

Mansoura University	Faculty of Engineering	Electronics and Comm. Dept.	4 th Year, Optical Communication Systems	6/10/2015	Sheet #1
---------------------	------------------------	-----------------------------	---	-----------	----------

Q1. Complete the following sentences

1. The characteristics of the deflector can be altered by applying
2. The characteristics of the devices can be altered by applying magnetic fields
3. The characteristics of the can be altered by applying electric fields.
4. Optical electronics are defined as.....
5. Optical circuit board communications are necessary for
6. Optical electronic chips are composed of and
7. Optoelectronic devices are based on the materials that have electrical conductivities within the range..... to
8. The electrical conductivities of the semiconductor materials can be altered by, and

Hint: see lecture 1

Q2. Derive the one dimensional time independent Schrödinger equation for isolated particle with mass m.

Hint: see lecture 2

Q3. Solve the Schrödinger for Hydrogen atom and answer the following:

- (a) Write down a relation for the energy values and draw it with explanation
- (b) Draw the wave function ψ for the first and the second energy states $n=1, 2$
- (c) Find the energy of the photon emitted as a particle makes a transition from $n=2$ state to $n=1$ state.

Hint: see lecture 2

Q4. In a region of space, a particle with mass m and with zero energy has a time independent wave function $\psi(x) = A e^{-x^2/l^2}$, where A and l are constants, determine the potential energy $U(x)$ of the particle.

Hint: Apply Schrödinger Equation and solution will be $U(x) = \frac{2h^2}{ml^4} (x^2 - \frac{3l^2}{2})$

Q5. A free electron has a wave function $\psi(x) = \sin(kx - \omega t)$, determine the de Broglie wavelength, momentum, kinetic energy and the speed of the electron when $k = 50 \text{ nm}^{-1}$

Hint: mass of the electron $m = 9.1 \times 10^{-31} \text{ Kg}$ and plank's constant $h = 6.626 \times 10^{-34} \text{ Kg/s}$

Q6. Solve the one dimensional time independent Schrödinger for particle in a box,

$$\text{where } U(x) = \begin{cases} 0 & 0 \leq x \leq a \\ \infty & \text{otherwise} \end{cases}$$

(a) Write down a relation for the energy values and draw it with explanation

(b) Determine the wave function $\psi(x)$

Hint: solution in the web link <https://www.youtube.com/watch?v=nFHhLJGDNHA>

Q7. Calculate an average number for the valence electrons per unit volume in semiconductor crystals.

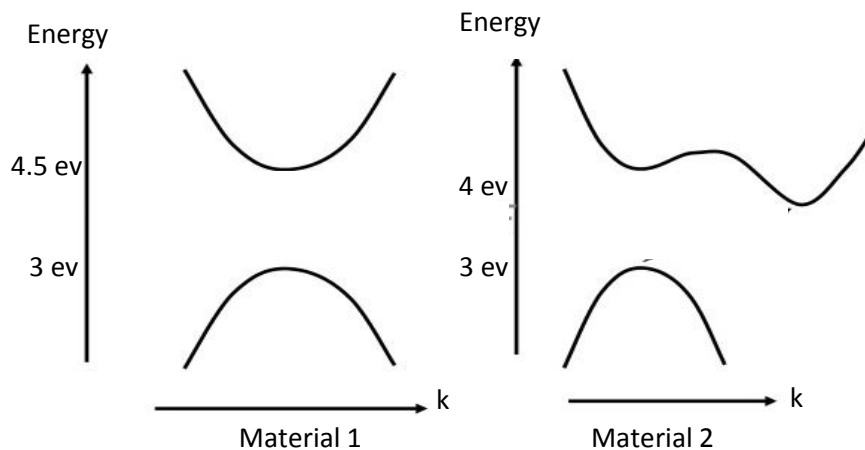
Hint: see *lecture 3*

Q8. Draw a relation between the atom energy and the interatomic spacing between atoms

Hint: see *lecture 3*

Q9. Define the wavelength (μm) of the (emitted /absorbed) photon of (from/by) the semiconductor materials silicon, Germanium and GaAs.

Q10. Determine the characteristics (mobility, effective mass, direct or indirect and the energy bandgap) of two semiconductor materials using their corresponding E-k Diagrams shown below.



Hint: see *lecture 3*

Best Wished

Assoc. Prof. Nihal Fayez